Source Apportionment Tools

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Air Toxics Exposure Assessment Workshop

Receptor Model Development and Testing

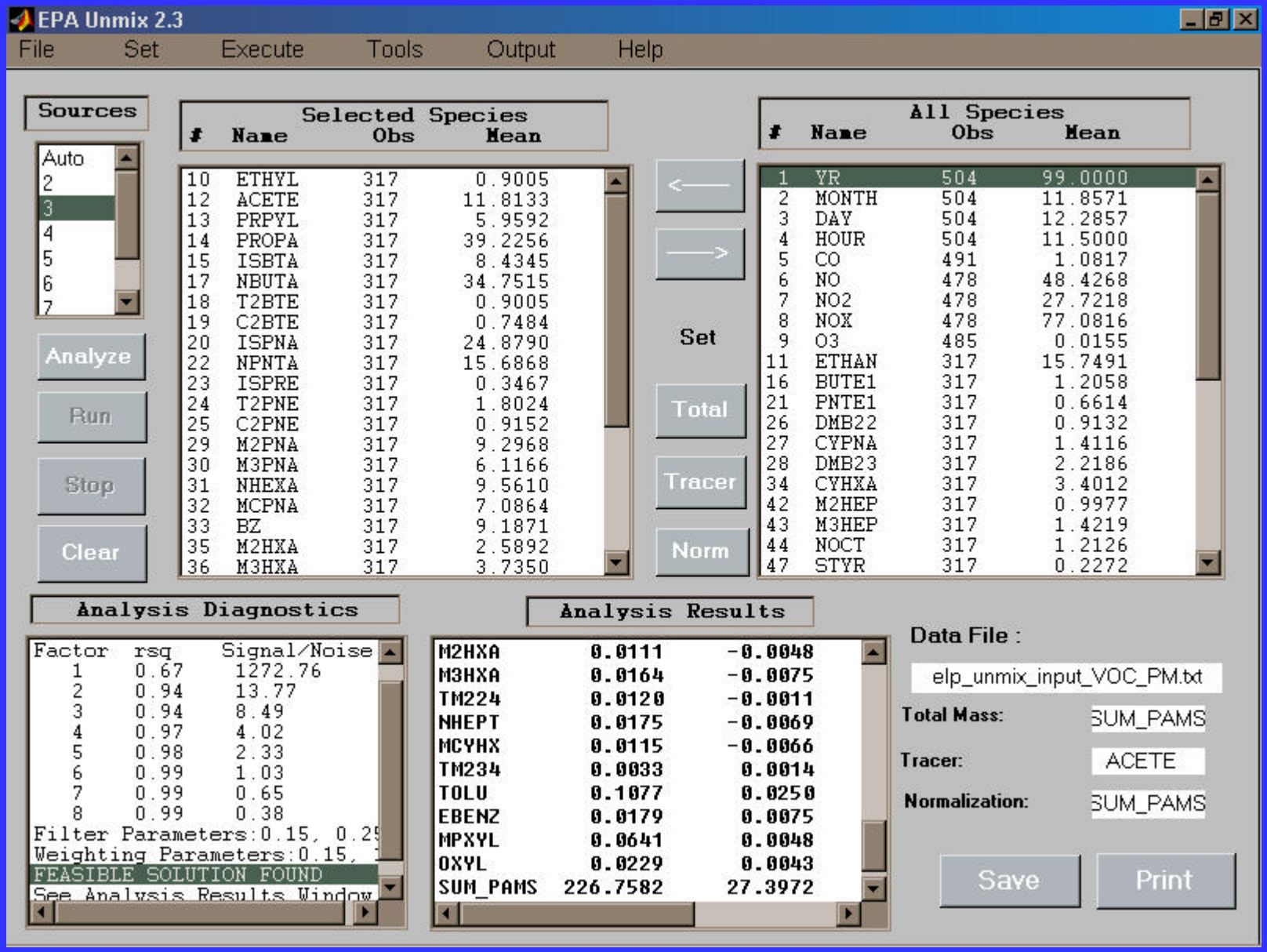
- Chemical Mass Balance (CMB)
  - EPA CMB 8.2 beta version (Nov. 2002)
- Unmix
  - EPA Unmix 2.3
  - VOC Example from El Paso, TX
- Positive Matrix Factorization (PMF)/ Multilinear Engine (ME)
  - Baltimore Retirement Home Example

Unmix

EPA Unmix 2.3

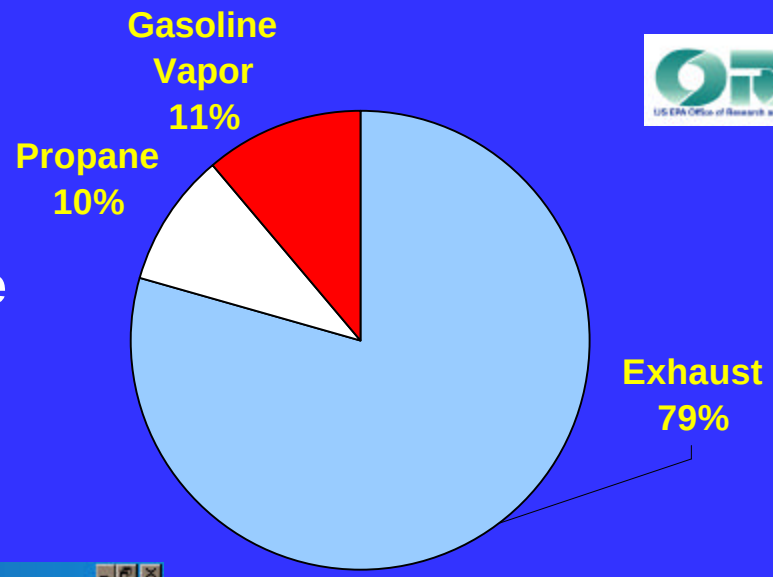
- constrained (non-negativity) factor analysis
- generates source profiles (& uncertainties) and source contributions from ambient data
- no explicit use of ambient data uncertainties
- no free parameters
- EPA Unmix 2.3 stand-alone version available

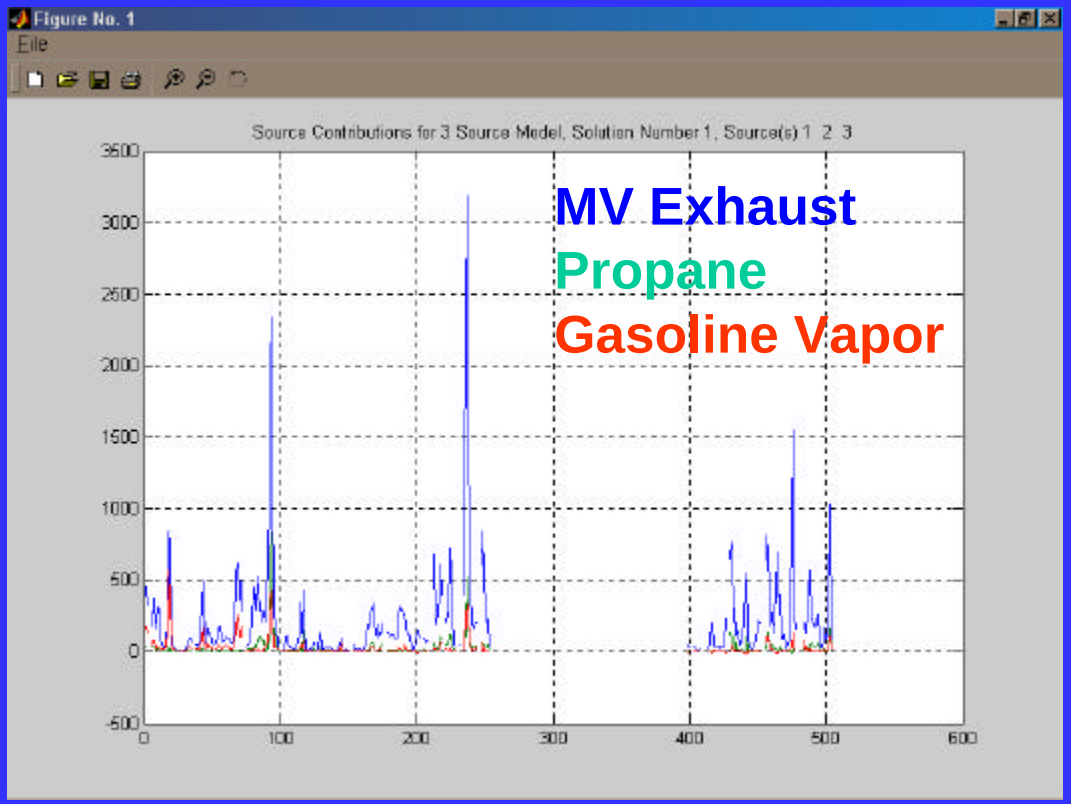
Unmix User-Interface



El Paso Unmix Results

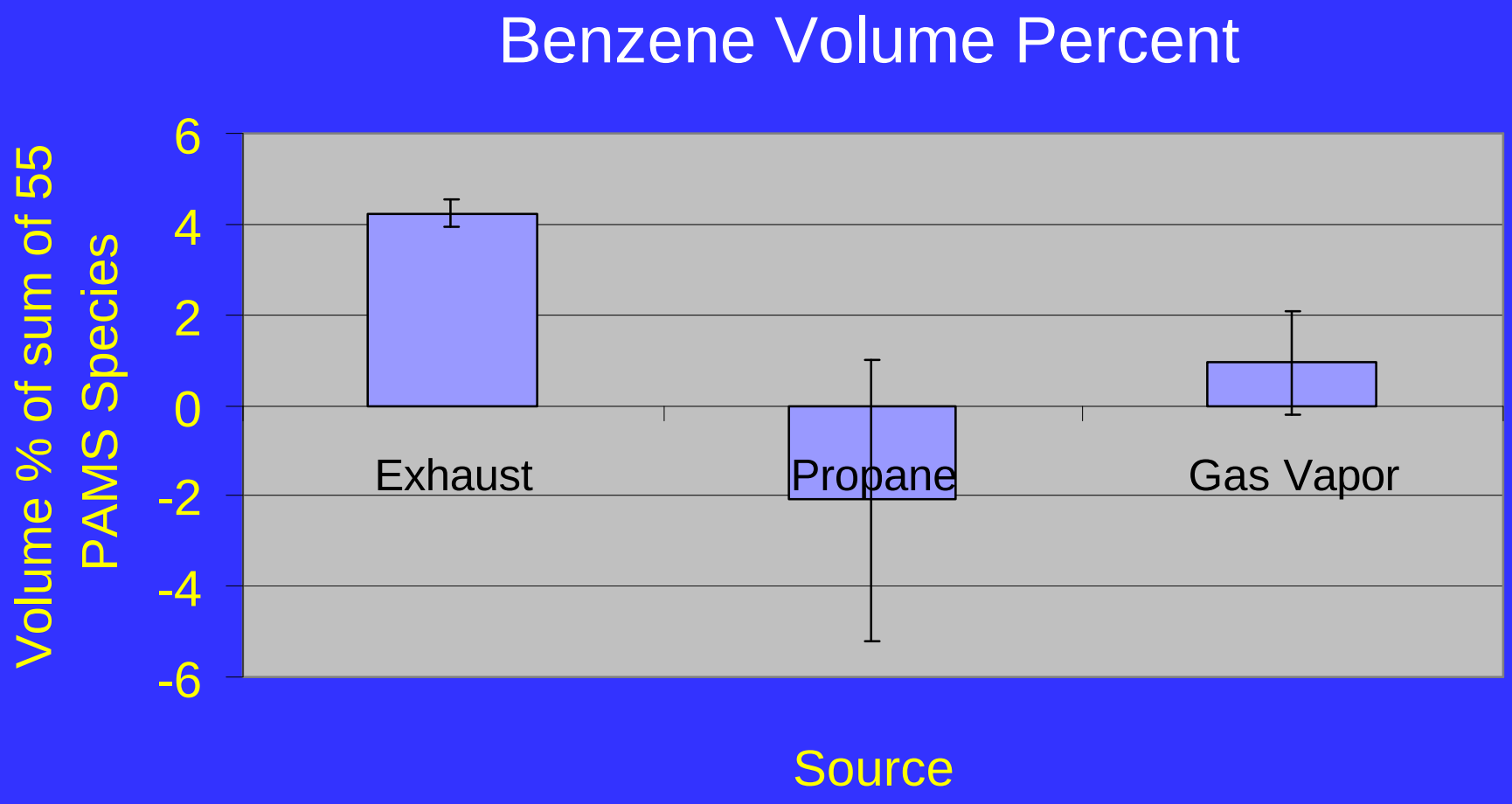
Average source contribution





Time series of source contributions

El Paso Unmix Results



Source Apportionment of PM Personal Exposure Data

ANALYSIS OF PARTICLE COMPOSITIONS MEASURED IN THE EPA 1998 BALTIMORE EXPOSURE PANEL STUDY

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EPA 1998 Baltimore PM Epidemiology - Exposure Study

PM personal exposure in a sensitive subpopulation

- **Monitoring period**
  - July 27 – Aug 22, 1998
- **Panel**
  - Elderly subjects with a mean age of 84
  - 18 story retirement home facility near Baltimore, MD
  - No smoking
  - Subjects typically did not cook in their apartments
  - Subjects spent 95 % of their time indoors

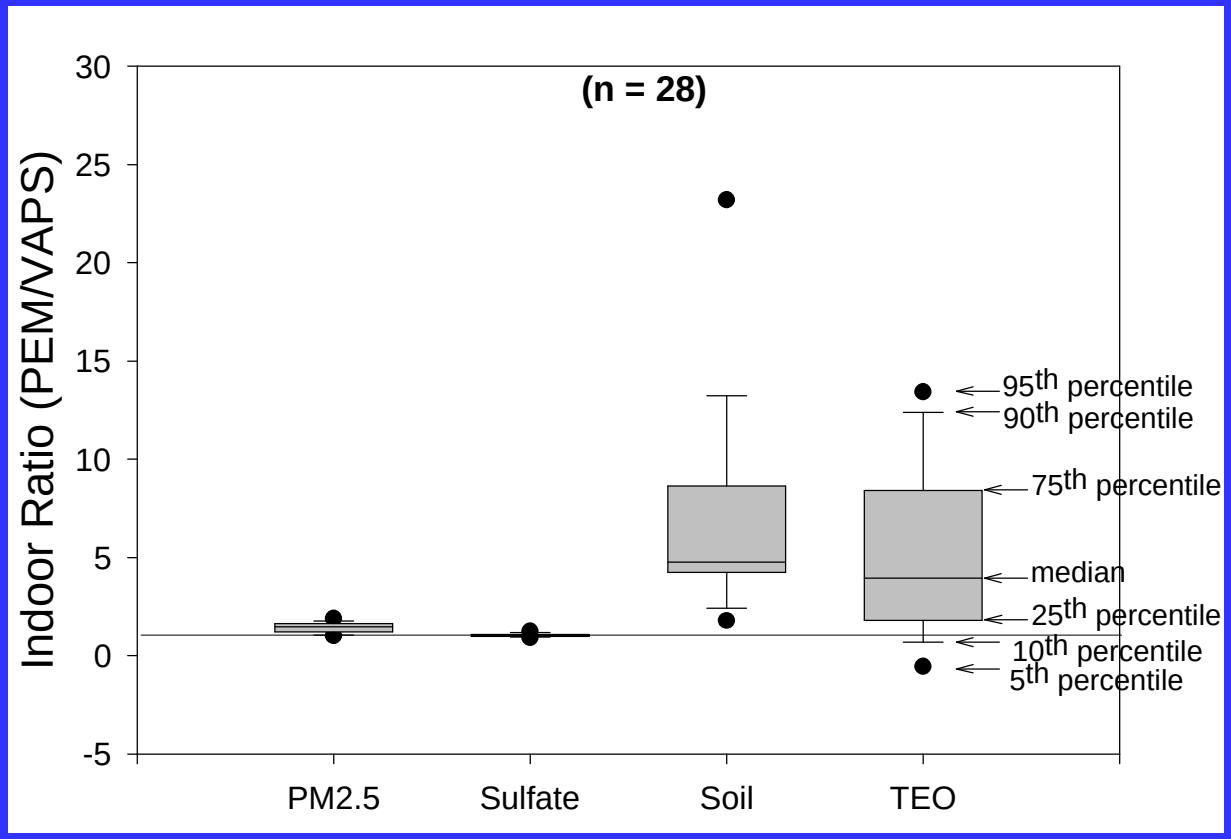
EPA 1998 Baltimore PM Epidemiology - Exposure Study

Integrated $PM_{2.5}$ measurements (24 hours)

- **Community, Outdoor, and Indoor**
  - Versatile Air Pollutant Sampler (VAPS, modified dichotomous sampler)
  - Mass, XRF, OC/EC, H^+, NH_4+, NO_3^-
- **Personal, Apartment, Indoor, Outdoor, Community $PM_{2.5}$**
  - Personal Exposure Monitor (PEM) with a $PM_{2.5}$ impactor
  - Mass, XRF

Sampling Issue 1

PEM sampler Soil and Trace Element Oxide (TEO) concentrations were higher than the VAPS concentrations.



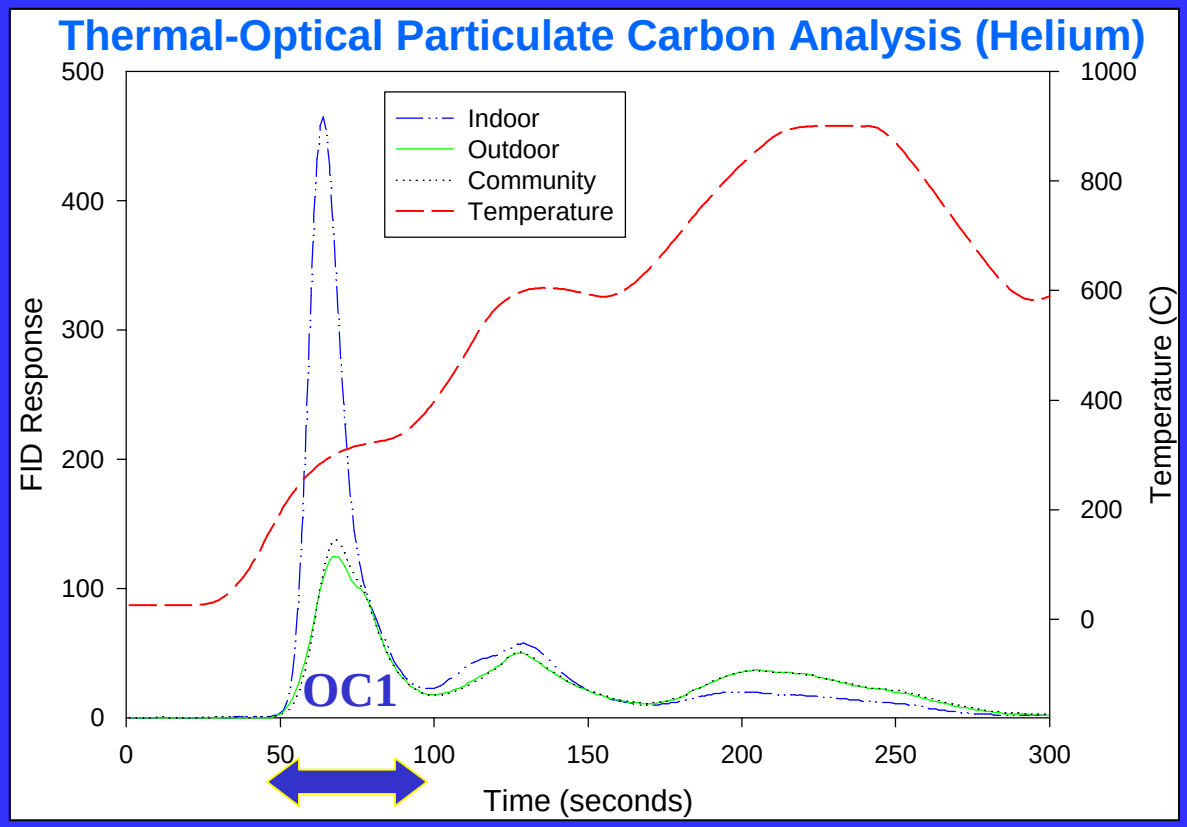
Based on these results, VAPS and PEM data were analyzed separately.

Sampling Issue 2

The organic carbon mass concentration (OC*1.4) collected with a quartz filter was significantly higher than the collocated $PM_{2.5}$ mass concentration collected on a Teflon filter (VAPS) .

OC*1.4 mass fraction of $PM_{2.5}$

Community: 34 %
Outdoor: 30 %
Indoor: 168 %



Sources & Infiltration

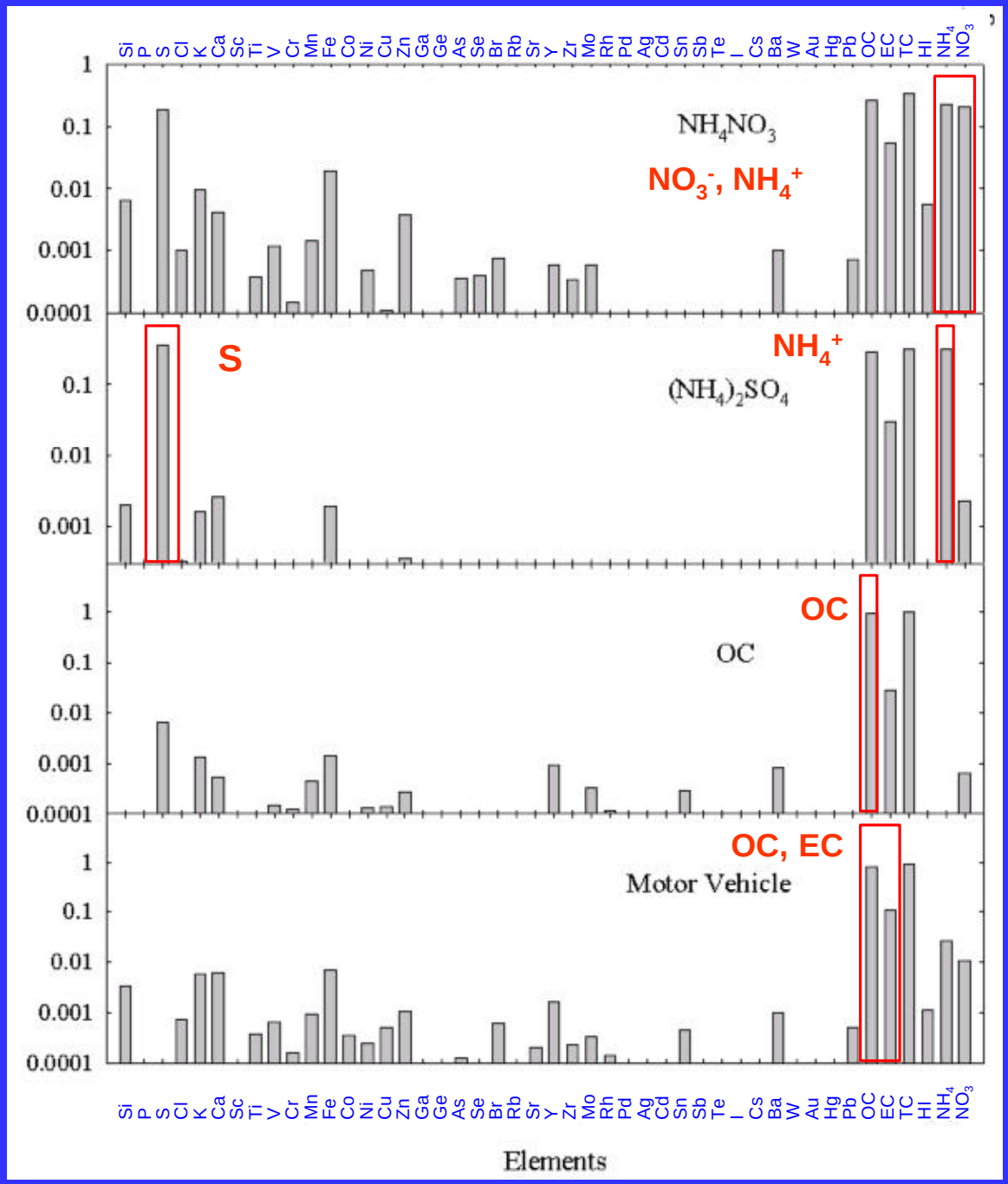
Contribution of $PM_{2.5}$ sources to the Community, Outdoor, and Indoor Sampling Sites

Positive Matrix Factorization 3

- VAPS data
- Sources contribute to all sites
- Time series pattern the same for all sites
- Relative contribution different for each site

Sources & Infiltration

Source Profiles From 3-way analysis

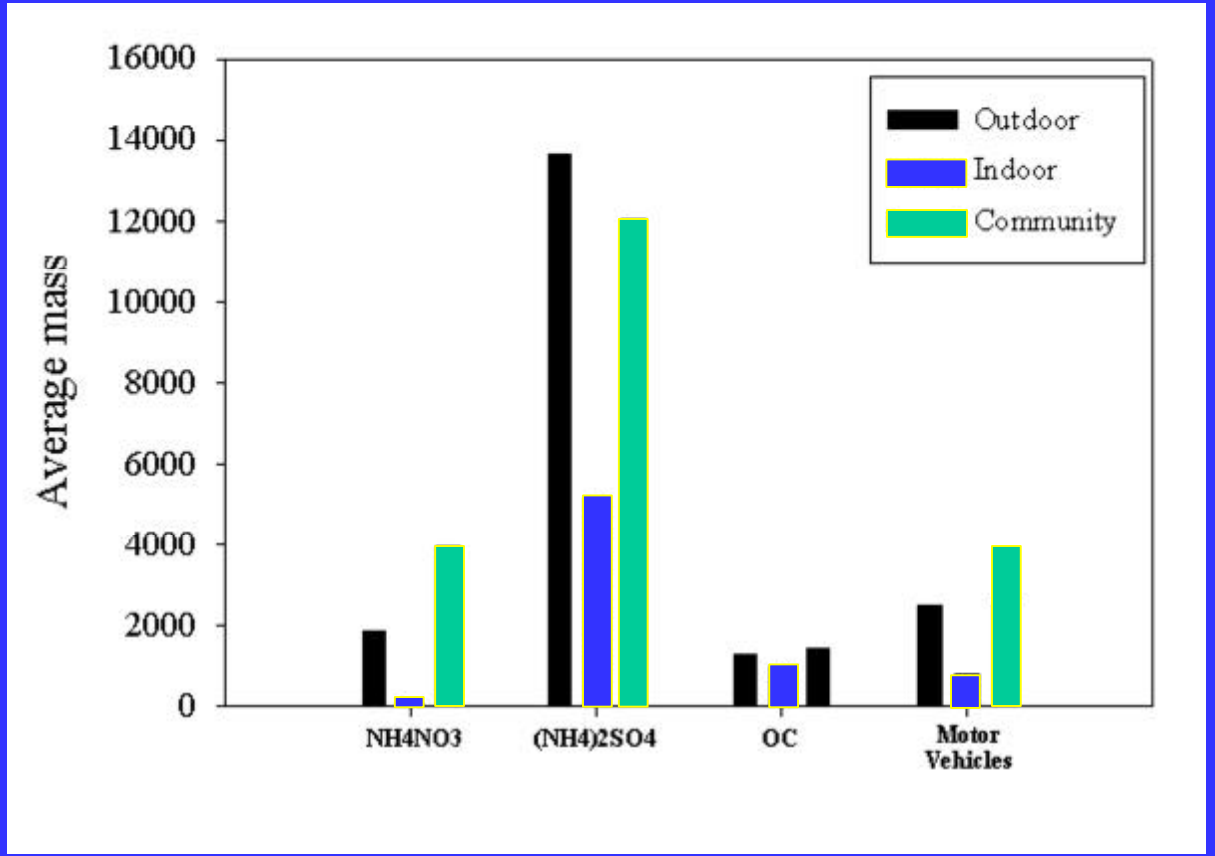


Sources & Infiltration

Infiltration of $PM_{2.5}$ sources from outdoor to indoor

$PM_{2.5}$:	35 %
Nitrate:	1.4 %
Sulfate:	43%
OC:	68 %
MV Exhaust:	32 %

Average Contributions



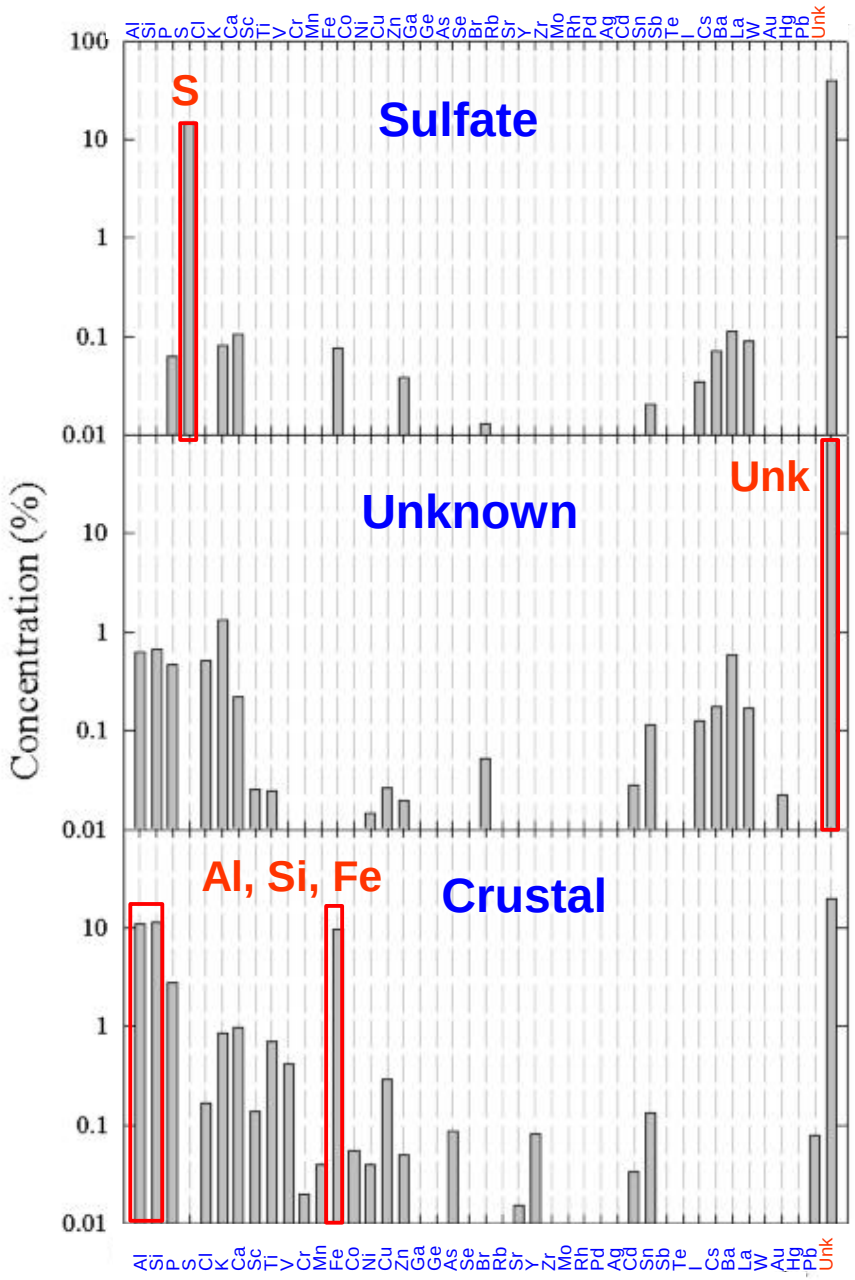
Sources & Personal Exposure

Sources of $PM_{2.5}$ Contributing to Personal Exposure

- PEM data
- Multilinear Engine 2
  - External factors contribute to all four environments (outdoor, indoor, personal, apartment).
  - Internal factors only contribute to personal and apartment samples.
  - Penalty function used to reduce the importance of the internal factors in the fitting process.
    - Make sure that as much of the observed concentration as possible is explained by external factors.

Sources & Personal Exposure

External Factors



Contribution

Personal: 48.4 %

Apartment: 68.6 %

Personal: 12.2 %

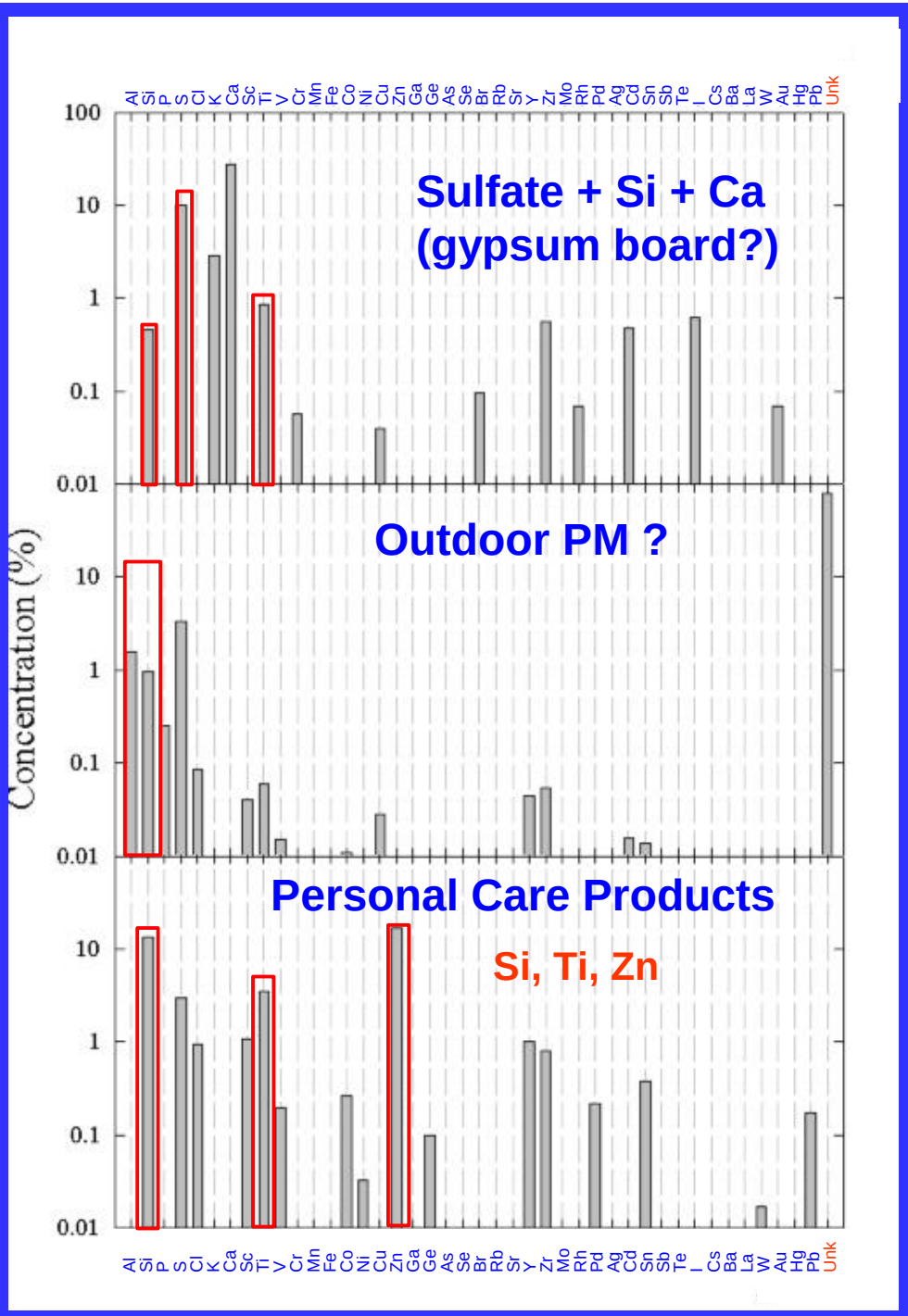
Apartment: 12.3 %

Personal: 2.4 %

Apartment: 2.5 %

Sources & Personal Exposure

Internal Factors



Contribution

Personal: 0.6 %

Apartment: 0.2 %

Personal: 36.1 %

Apartment: 16.1 %

Personal: 0.4 %

Apartment: 0.2 %

Unidentified Outdoor PM Source?

Measured on personal and apartment samples but not by the stationary outdoor and indoor monitors.

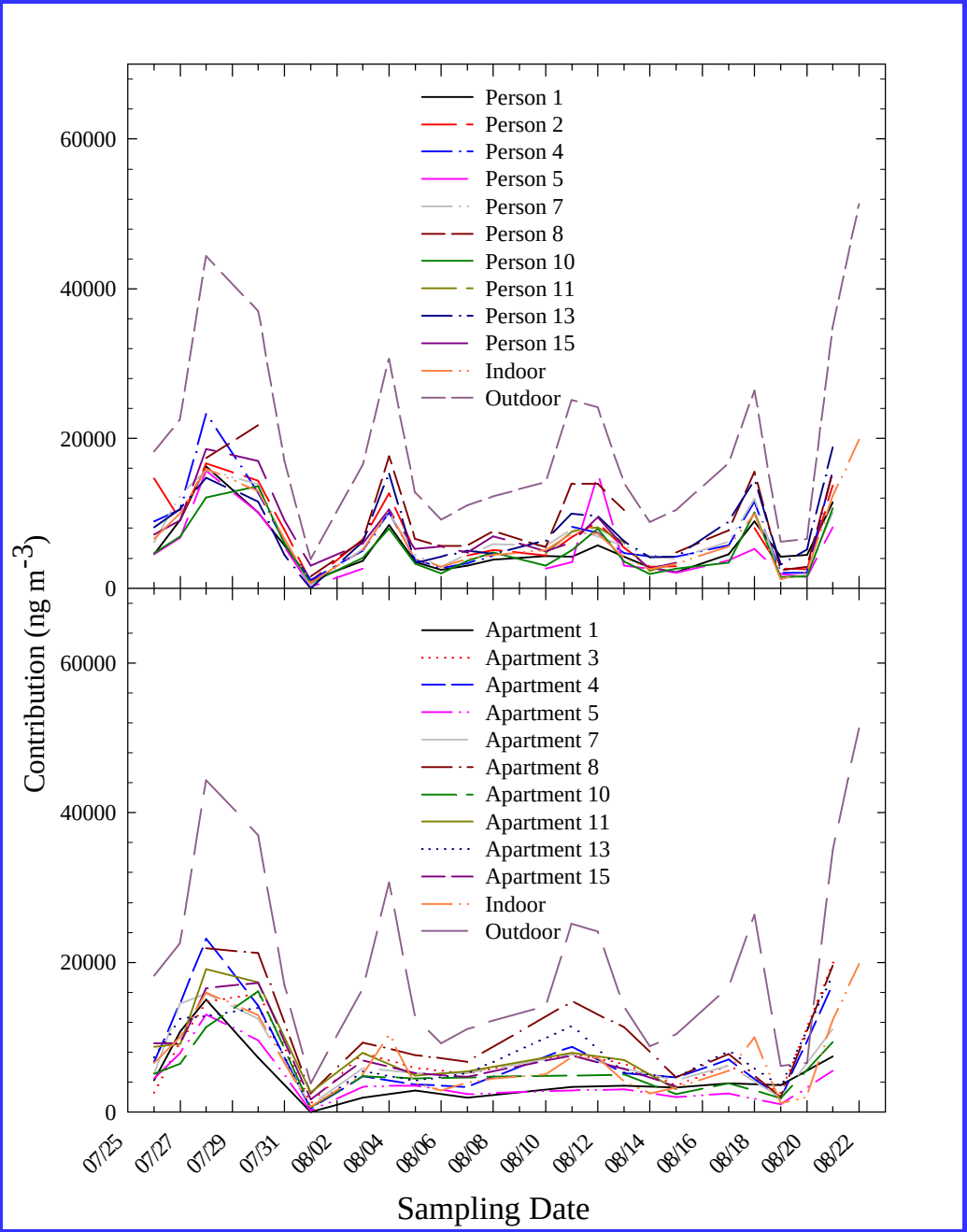
- **Need to evaluate the relationship between the time spent outdoors and in vehicles with the Outdoor PM contribution.**

- **Include activity data and PM species in the receptor model. This could help identify sources contributing to the Outdoor PM.**

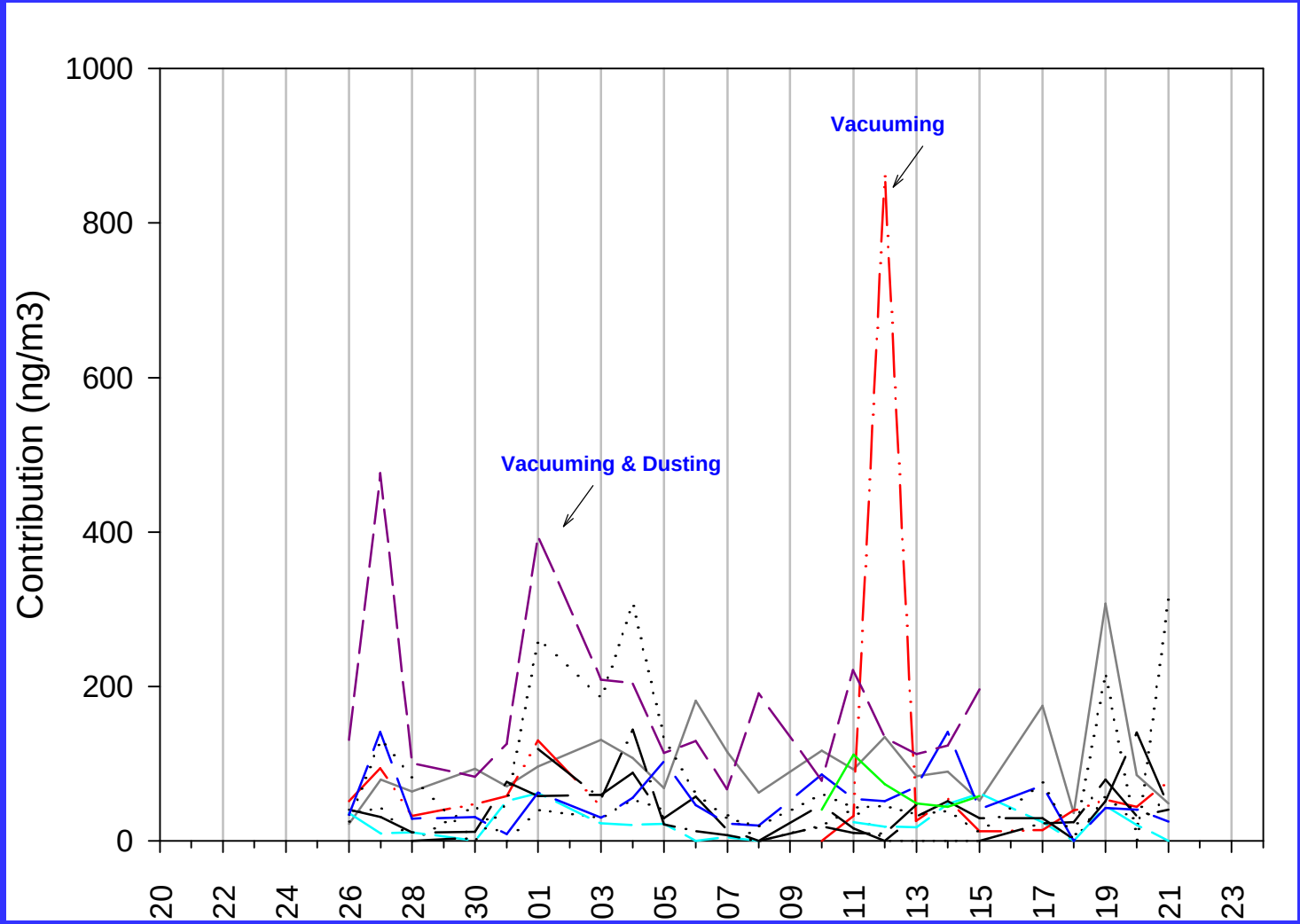
Sources & Personal Exposure

Time series of external factor 1:

Sulfate



Source Contributions of Internal Factor 1



Personal Exposure to Motor Vehicle Exhaust

Can we determine personal exposure to motor vehicle PM exhaust ?

Problems

- Pb is no longer a tracer for motor vehicle exhaust
- Large OC positive artifact on indoor and personal samples (EPA Panel Study Data)

Research Areas

- Add OC1 to the receptor model to estimate OC artifact
- Quantify EC on Teflon filters using transmittance
- Use time activity data in the receptor model